

Patent Application No. 09/605,227
Attorney Docket No. 81870.0009

REMARKS:

Claims 1, 5, and 7 are amended. New claims 18-29 are added. Claims 1-29 are pending in the application. No new matter is added. Reexamination and reconsideration of the application, as amended, are respectfully requested.

The present invention relates to an optical module and a connecting structure for an optical module which are used mainly in optical communication equipment or the like. (Applicant's specification, at p. 1, lines 1-4). The optical modules and connection structures of the present invention enable secure and easy mounting on an electric circuit board and are highly reliable. (Applicant's specification, at p. 4, lines 22-25).

CLAIM REJECTIONS UNDER 35 U.S.C § 102:

Claim 1 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Miura et al. (U.S. Patent No. 5,748,822). Applicant respectfully traverses this rejection. Claim 1, as amended, is as follows:

An optical module comprising:

a substrate having a planar main surface and a groove in the main surface of the substrate;

an electric connection terminal provided on the substrate;

an optical element completely provided on the planar main surface of the substrate, the optical element being connected with the electric connection terminal; and

one end of a slender light transmitter fixed in the groove and optically coupled with the optical element,

wherein the light transmitter immediately adjacent to the optical element is fixed in the groove.

Claim 1 was amended to clarify that 1) an optical element is completely provided on the planar main surface, and 2) the light transmitter immediately

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adjacent to the optical element is fixed in the groove. Applicant respectfully submits that Miura cannot anticipate claim 1 because Miura does not teach or suggest 1) an optical element that is completely provided on the planar main surface and 2) one end of a slender light transmitter fixed in the groove and optically coupled with the optical element, wherein the light transmitter immediately adjacent to the optical element is fixed in the groove.

The Office relies on Miura's sixth embodiment (column 12, lines 4-65) to reject claim 1. Miura states, "[i]n the sixth embodiment which will be described below, the optical module of the first embodiment is enclosed by a metal case. Also, the optical modules of the second through fifth embodiments may be enclosed by a metal case in a similar manner." (Miura, column 12, lines 4-8). The Applicant respectfully submits that embodiments one through five together with embodiment six do not teach or suggest the limitations discussed above.

In Miura's first embodiment, "a positioning mark 24, which is used to position the laser-diode (LD) 28 on the mounting board 21, is formed adjacent to the edge of the V-groove 31. A transverse groove 29 which crosses the V-groove 31 on the mounting board 21 and extends in a direction perpendicular to the optical axis of the optical fiber 31, is formed on the mounting board 21. A vertical wall 29a is formed by the edge of the V-groove 31, and is perpendicular to the direction of the optical axis of the optical fiber 30. The vertical wall 29a is provided as a stopper for positioning the optical fiber 30 when inserted, in the direction of the optical axis of the optical fiber 30." (Miura, column 5, lines 27-39). The transverse groove 29 (Miura, Figure 2A) creates an empty groove-less portion adjacent to the optical element 28 and consequently, the light transmitter immediately adjacent to the optical element is not fixed in the groove because the V-groove ends where the empty portion begins.

In Miura's second embodiment (Figures 4A-4C, 5A, 5B, and column 7, lines 11-45), "[w]hen the laser-diode 28 is packaged on the mounting board 21A, the positioning of the laser-diode 28 on the mounting board 21A can be performed by

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viewing the positioning mark 24A. As shown in FIGS. 5A and 5B, the laser diode 28 is partially overlapped on the positioning mark 24A, and the laser-diode 28 located at a packaging location 26A, after the positioning is performed, projects from the edge of the V-groove 31A toward the inside of the V-groove 31A." (Miura, column 7, lines 36-44). The optical element 28 is projecting from the edge of the V-groove and consequently, the optical element is not completely provided on the planar main surface of the substrate. Furthermore, according to Miura's second embodiment, an insulating layer 20A separates the laser-diode 28 from the mounting board 21A. (Miura, column 7, lines 18-22 and Figure 5A). Therefore, the entire optical element 28 is provided on the insulating layer 20A and not the planar main surface of the substrate 21A.

Figures 6A, 6B, 7A, and 7B (Miura) refer to the third embodiment of Miura's invention (column 8, line 4-column 9, line 28). Miura states "[a]s shown in FIG. 6A, an optical fiber stopper 36 and a laser-diode positioning mark (not shown) which are similar to those of the first and second embodiments are formed on a mounting board 35 (the silicon substrate). Similarly to the first and second embodiments, a V-groove 42 for enclosing the optical fiber 30 is formed in the middle of the mounting board 35. The V-groove 42 extends in the longitudinal direction of the mounting board 35." (Miura, column 8, lines 9-16). Since Miura states that the third embodiment is similar to either the first or second embodiment in terms of an optical fiber stopper and a laser-diode positioning mark formed on the mounting board and neither the first nor the second embodiment teach or suggest the limitations discussed above, the Applicant concludes that the third embodiment does not teach or suggest the limitations discussed above. The difference between the third embodiment and the earlier embodiments rests primarily on the addition of fitting grooves 37 to the mounting board 35 and the addition of a retaining board 38, 38A that goes on top of the mounting board. (Miura, column 8, lines 17-31, Figures 6A, 6B; column 8, line 66-column 9, line 11, Figures 7A, 7B).

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The fourth embodiment of Miura is similar to those of the first three embodiments with the major exception being the use of a glass capillary 43 that is placed into the V-groove 42 on the mounting board 35A, and the glass capillary 43 and the mounting board 35A are fixed together by using an adhesive agent. (Miura, column 9, lines 29-55). Since the fourth embodiment relies on the first and second embodiments for teaching an optical fiber stopper and a laser-diode positioning mark formed on the mounting board and neither the first nor the second embodiment teach or suggest the limitations discussed above, the fourth embodiment does not teach or suggest every claim limitation as discussed above.

Miura describes the fifth embodiment as follows: "FIGS. 11A through 11D show a photo-diode array module to which the fifth embodiment of the present invention is applied. As shown in FIG. 11A, a plurality of V-grooves 54B and a recessed portion 54C are formed on a mounting board 57 (the silicon substrate) by etching. Sloping surfaces of the V-grooves 54B and a sloping surface 54D of the recessed portion 54C are formed by (111) plane of the silicon crystal structure which depend on the characteristics of the crystal structure of the silicon substrate. The top surface of the mounting board 57 is formed by (100) plane of the silicon crystal structure. As shown in FIG. 11B, a plurality of electrodes 58 (Au) are formed on the mounting board 57. The electrodes 58 extend from the sloping surface 54D (the array mounting surface) of the recessed portion 54C. Further, a solder layer 59 is formed on the array mounting surface 54D. As shown in FIG. 11C, a photo-diode array 60, including a plurality of photo-diodes of the type having the light receiving surface on the bottom side, is placed on the solder layer 59. The photo-diode array 60 is fixed to the solder layer 59 on the array mounting surface 54D by soldering. As shown in FIG. 11D, an optical fiber array 30A including a plurality of optical fibers is placed on the V-grooves 54B. A retaining board 61 (the silicon substrate) is placed on the optical fibers of the optical fiber array 30A, and the optical fibers are retained by the retaining board 61." (Miura, column 11, lines 13-39). As shown in FIG. 11A, a plurality of V-grooves 54B and a recessed portion 54C are formed on a

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mounting board 57 (the silicon substrate) by etching. The photodiode array is placed on the recessed portion. The grooves however, are not apparently formed in the recessed portion. Thus, the light transmitter immediately adjacent to the optical element is not fixed in the groove because the light transmitter is in a recessed portion that contains no grooves.

As noted above, Miura's sixth embodiment is the optical module of the first embodiment which is enclosed by a metal case. (Miura, column 12, lines 4-8). Thus, in Miura, Figures 13A-G, which refer to the sixth embodiment, use the optical module of the first embodiment. As noted above, since nothing in the first embodiment teaches or suggests 1) an optical element that is completely provided on the planar main surface and 2) one end of a slender light transmitter fixed in the groove and optically coupled with the optical element, wherein the light transmitter immediately adjacent to the optical element is fixed in the groove, the sixth embodiment does not teach or suggest each and every claim limitation.

In Figures 13A and 13B, the mounting board 21 with the optical element 28 is joined to a base 73 of a metal case 63 using a solder sheet 75. (Miura, column 12, lines 11-13). In Figure 13E, after a wire bonding for electrical connection is performed, a lid 66 (the material of which is the same as the material of the metal case 63) is placed on the metal case 63 and the inside of the metal case 63 is hermetically sealed by the lid 66. (Miura, column 12, lines 36-40). Thus, Figures 13A-B of the sixth embodiment include the use of a metal case over the optical module of the first embodiment; and Figure 13E includes the use of a metal case and lid over the optical module of the first embodiment.

Also as noted above, Miura's sixth embodiment can use the optical modules of the second through fifth embodiments in place of the optical module of the first embodiment. Thus if Figures 13A-G were to represent the optical modules of the second through fifth embodiments enclosed by a metal case, there would still be nothing in the sixth embodiment to teach or suggest 1) an optical element that is completely provided on the planar main surface and 2) one end of a slender light

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transmitter fixed in the groove and optically coupled with the optical element, wherein the light transmitter immediately adjacent to the optical element is fixed in the groove, the sixth embodiment does not teach or suggest each and every claim limitation.

Furthermore, since nothing in Miura teaches or suggests each and every claim limitation, present claim 1 patentably distinguishes over Miura. Withdrawal of this rejection is thus respectfully requested.

CLAIM REJECTIONS UNDER 35 U.S.C § 103:

Claims 1-17 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Beckwith (U.S. Patent No. 5,615,292) in view of Miura et al. (U.S. Patent No. 5,748,822). Applicant respectfully traverses these rejections.

Applicant respectfully submits that the combination of Beckwith and Miura cannot render present claim 1 obvious because the combination of references does not teach or suggest 1) an optical element that is completely provided on the planar main surface and 2) one end of a slender light transmitter fixed in the groove and optically coupled with the optical element, wherein the light transmitter immediately adjacent to the optical element is fixed in the groove.

Miura has already been discussed, supra. Beckwith is directed to a terminator for permanent connection to either end of a fiber optic cable which then provides transmission of electrical TTL logic signals from one end to the other. (See Beckwith, Abstract). As noted by the Office, Beckwith "does not teach the use of substrates having grooves and at least a portion of the optical device disposed in the groove" and consequently, Beckwith cannot remedy the defect of Miura.

In light of the foregoing, Applicant respectfully submits that Beckwith and Miura could not have made amended claim 1 obvious, because the combination of references do not teach or suggest each and every claim limitation. Withdrawal of the rejection and allowance of amended claim 1 is respectfully requested.

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Claims 2-4 depend from claim 1, and as such include all the limitations of amended claim 1, and therefore cannot be made obvious for at least the same reasons as claim 1. Withdrawal of the rejection and allowance of claims 2-4 is thus respectfully requested.

Claim 7, as amended, is as follows:

A combination comprising:
a connector connectable with an electric circuit board; and
an optical module including:
a substrate having a planar main surface and a groove in the main surface of the substrate;
an electric connection terminal provided on the substrate, the electric connection terminal electrically connectable with the connector;
an optical element completely provided on the main surface of the substrate, the optical element being connected with the electric connection terminal; and
one end of a slender light transmitter fixed in the groove and optically coupled with the optical element,
wherein the light transmitter immediately adjacent to the optical element is fixed in the groove.

Claim 7, although not depending from claim 1, has all the limitations of amended claim 1, and therefore cannot be made obvious for at least the same reasons as claim 1. Withdrawal of this rejection and allowance of claim 7 is thus respectfully requested.

Claims 8-17 depend from claim 7, and as such include all the limitations of amended claim 7, and therefore cannot be made obvious for at least the same reasons as claim 7. Withdrawal of the rejection and allowance of claims 8-17 is thus respectfully requested.

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Claim 5, as amended, is as follows:

An optical module comprising:

a substrate having a planar main surface and a groove in the main surface of the substrate;

an electric connection terminal provided on the substrate;

a planer lightwave circuit completely provided on the main surface of the substrate, the planer lightwave circuit being connected with the electric connection terminal; and

an optical fiber partially provided in the groove and optically coupled with the planer lightwave circuit,

wherein the optical fiber immediately adjacent to the planer lightwave circuit is fixed in the groove.

Claim 5, although not depending from claim 1, has all the limitations of amended claim 1, with the minor exceptions that a planer lightwave circuit is used as an optical element and an optical fiber is used as a light transmitter. Furthermore, neither Muira nor Beckwith teach or suggest the use of a planer lightwave circuit. Therefore, amended claim 5 cannot be made obvious for at least the same reasons as claim 1. Withdrawal of this rejection and allowance of claim 5 is thus respectfully requested.

Claim 6 depends from claim 5, and as such includes all the limitations of amended claim 5, and therefore cannot be made obvious for at least the same reasons as claim 5. Withdrawal of the rejection and allowance of claim 6 is thus respectfully requested.

New claims 18-29 are similarly believed to be patentable over the art of record. These new claims serve to clarify the following feature of the present invention: The mounting of electric terminals, which need not have high precision, is accomplished on a package casing which is made of an inexpensive material such as ceramics. On the other hand, the mounting of an optical fiber and an optical

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element that requires high precision is accomplished on a substrate. The substrate can be attached on the package casing after being mounted with the optical fiber and optical element. Consequently, a small-sized optical module can be more easily manufactured, which results in a considerable reduction of production costs.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

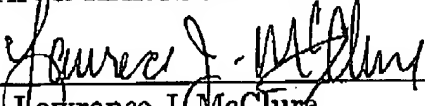
If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (213) 337-6810 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

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